CLAIMS

1. An extreme ultraviolet photolithography method in which:

- an object (OBJ) to be lithographed possesses a plane surface, placed orthogonally to the light radiation and having a photosensitive zone (PR), this object being able to be moved (41) transversely to this radiation (23);

- the radiation (23) carrying out the etching operation includes at least one line in the extreme ultraviolet and consists of N successive current pulses whose energy per unit area through an irradiation window (40) is measured; and

- these radiation pulses are produced by the impact, on a suitable target (21), of at least two laser beams output by pulsed laser sources (10-19) chosen from a plurality thereof, each emitting at each triggering a quantum (Q) of energy of given duration (Δt), these laser sources being focused at the same point on the target,

this method being characterized in that it comprises the following iterative steps, stated for an nth iteration:

a) integration of the energy per unit area of extreme ultraviolet radiation that has passed through the irradiation window during the N - 1 last pulses;

b) during the time interval separating two successive radiation pulses, translation of the photosensitive object through a distance equal to a fraction 1/N of the width (L) of the irradiation window along the axis of this translation;

c) subtraction of the integral obtained in step a) from the quantity of energy (W_{tot}) needed for the photoetching process;

d) determination of the quantity of energy remaining to be provided in order to reach this quantity of energy (W_{tot});

e) calculation of the number of pulse quanta 30 remaining to be generated for an nth pulse;

f) determination of the corresponding number of laser sources to be fired and selection of laser sources whose number is equal to the integer part of this number; and

g) synchronous triggering of the lasers selected at step f),

these steps a) to g) being repeated for the next current point.

2. The method as claimed in claim 1, in which the number of laser sources calculated at step f) is fractional and the quantity of energy less than one quantum, associated with this fractional part of the number of lasers, is provided by a laser source capable of delivering the quantum of energy common to the other laser sources and is triggered with a delay, of less than the duration (Δt) of a quantum, relative to the instant of synchronous triggering of the other laser sources that deliver the integer part of the number of quanta of the same current pulse.

3. The method as claimed in claim 1, in which the number of laser sources calculated at step f) is fractional and the quantity of energy less than one quantum, associated with this fractional part of the number of lasers, is provided by a laser source capable of delivering an amount of energy of less than one quantum and triggered with a delay, of less than the duration (Δt) of a quantum, relative to the instant of synchronous triggering of the other laser sources that deliver the integer part of the number of quanta of the same current pulse.

4. The method as claimed in either of claims 2 and 3, in which the number of laser sources calculated at step f) is fractional and the quantity of energy less than one quantum, associated with this fractional part of

the number of lasers, is provided by several laser sources of which:

- the first is triggered with a delay of $(1-k_1)\Delta t$, where $0 < k_1 < 1$, after the instant of triggering of the synchronous lasers that represent the integer part of the number of lasers;

- the second is triggered with a delay of $(1-k_2)\Delta t$, where $k_1 < k_2 < 1$, after the instant of triggering of the synchronous lasers that represent the integer part of the number of lasers;

- and so on, the qth being triggered with a delay of $(1-k_q)\Delta t$, where $0 < k_q < 1$, after the instant of triggering of the synchronous lasers that represent the integer part of the number of lasers; and, furthermore

- the sum of these delays is less than the duration Δt of a quantum.

5. The method as claimed in one of claims 2 to 4, characterized in that the following are triggered:

- at least a first laser shot at a predetermined instant (t_{11}), and

- one or more successive laser shots at respective instants chosen to adjust the energy of an extreme ultraviolet pulse to be emitted, these respective instants being distributed within a time interval shorter than said duration (Δt) of the shots.

6. The method as claimed in one of the preceding claims, characterized in that the laser sources are actuated so as to emit laser shots repetitively with a mean frequency substantially defining a repetition period of the pulses that emit the plasma and in that the displacement of the object relative to the radiation is substantially continuous with a speed (V) corresponding to a fraction 1/N of the width of the window (L) divided by a pulse repetition period.

7. The method as claimed in one of the preceding claims, characterized in that it commences

substantially with the following steps:

a0) the photosensitive object to be lithographed is positioned beneath the window so that only a zone slice to be irradiated that has a width equal to said fraction 1/N of the window width is exposed;

a1) at least some of the laser sources are selected so as to excite the plasma-generating target, and a current pulse in the zone to be irradiated is triggered;

a2) the peak power of the current extreme ultraviolet pulse actually delivered to the zone of the object to be irradiated is measured;

a3) the object is displaced relative to the window by a position increment equal to said fraction 1/N of the window width;

a4) steps a1) to a3) are repeated as long as the zone of the object to be irradiated, located beneath the window, is narrower than the window, by delivering pulses with energies estimated by subtracting, from the energy (W_{tot}) to be delivered for photoetching the object, the sum of the energies measured during the n successive passes through step a2), and then by dividing the result of the subtraction by N-n, where n is an integer smaller than the predetermined number of pulses N; and

a5) when the zone of the object to be irradiated, located beneath the window, reaches the width of the window, the precise amount of energy remaining to be provided is estimated, so that the slice of the zone to be photoetched receiving its final pulse receives the total quantity of energy (W_{tot}) for photoetching it.

8. An extreme ultraviolet photolithography device comprising:

- a source of extreme ultraviolet radiation, comprising at least two laser beams output by pulsed laser sources (10-19), each emitting a quantum of energy (Q) of given duration (Δt) during a laser shot and capable of exciting one and the same region of a

target (21) that is able to emit a plasma possessing an emission line in the extreme ultraviolet;

- an irradiation window (40) of chosen width (L), interposed between the radiation source and the object (OBJ) and stationary relative to the radiation source (20, 22); and

- means (41) for the transverse displacement, relative to the window, of an object (OBJ) to be photolithographed that has a plane surface, orthogonal to the radiation, and has a photosensitive zone (PR), said displacement being chosen so that, between two successive pulses of extreme ultraviolet radiation, the transverse displacement of the object (OBJ) relative to the window is a fraction 1/N of the width of the irradiation window in the direction of the displacement, in such a way that any one band (Z1, Z2) of said zone of the object is exposed to a predetermined number N of successive pulses in the extreme ultraviolet,

characterized in that it includes:

- means (31) for measuring the energy per unit area of the radiation through the irradiation window (40);

- means for calculating, for the current nth pulse to be delivered:

* the sum of the measured energy of the extreme ultraviolet radiation of the N-1 last pulses,

* the quantity of energy remaining to be delivered by the next nth pulse, by comparing said sum with a predetermined total energy dose (W_{tot}) needed for the photoetching, and

* the number of quanta of energy that the laser sources have to deliver in order to obtain said quantity of energy of said nth pulse; and

- means (30) for selecting and controlling, synchronously, a chosen number of lasers according to the calculated number of quanta,

and in that the means for displacing the object to be photoetched relative to the radiation are active, so as

subsequently to displace the object by an increment equivalent to said fraction 1/N of the width of the window.

9. The device as claimed in claim 8, characterized in that the calculation means (33) are designed to estimate instants of laser firings in order to adjust the energy of a pulse to be emitted in the extreme ultraviolet and in that the control means (PG, PS, AOM1-AOM10) are designed to introduce a time delay in the laser firings within a time interval between shots that is shorter than said duration (Δt) of the shots.

10. The device as claimed in claim 9, characterized in that the control means comprise acoustooptic modulators (AOM1-AOM10), for actuating each laser source at a chosen instant, and a radiofrequency power supply (PS) for actuating said acoustooptic modulators and in that said power supply and said modulators are capable of operating at a maximum frequency greater, by at least a factor of the order of a thousand, than the frequency of the extreme ultraviolet pulses.

11. The device as claimed in either of claims 9 and 10, characterized in that said sensor (31), on the one hand, has a chosen acquisition time and the calculating means (33), on the other hand, are equipped with a processor having a chosen processing frequency, in such a way that the sensor and the calculating means are capable of operating jointly over a period shorter than the extreme ultraviolet pulse repetition period.

12. The device as claimed in one of claims 8 to 11, characterized in that said target is a xenon jet.

13. The device as claimed in one of claims 8 to 11, characterized in that said target is a directed jet of particles comprising xenon and/or water microdroplets in the form of a mist.

14. The device as claimed in one of claims 8 to 13, characterized in that the laser shots are output by pulsed solid-state lasers operating as oscillators and pumped by continuously operating diodes.

15. The device as claimed in one of claims 8 to 14, characterized in that the fractional part of the number of lasers is represented by a quantum of energy delayed with respect to the synchronous triggering of the previous lasers and in that the selection means are capable of generating these delays according to the magnitude of the fractional part of the number of lasers, in order to generate said current nth pulse.

16. The device as claimed in one of claims 8 to 15, characterized in that the selection means are designed to trigger a remaining number of lasers not contributing to the emission of an extreme ultraviolet pulse, separately, so that the separate shots, output by these lasers, are not sufficient to emit an extreme ultraviolet pulse.